bers of the fauna and the flora. There has been very probably a distribution from the north and there may have been an antarctic center of dispersion, though there appears to be no evidence within the group itself which would justify a definite opinion as to this.

[1] McCulloch, *Econ. Ent. J.*, **10**, 1917, (162–168).
[2] *Ibid.*, **10**, 1917, (170–176).

FERTILITY AND AGE IN THE DOMESTIC FOWL

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It has been shown by Marshall,[1] Pearl,[2] and King,[3] that in a variety of different mammals fertility changes with the age of the animal in a definite way. The nature of this change is that, starting at a low point at the beginning of the sexual life, the rate of fertility rises with advancing age to a maximum, and then declines with further increase in age, until total sterility is reached. Marshall inclined to the view, on the basis of statistics which I have elsewhere[4] shown to be wholly inadequate, that the domestic fowl exhibited the same sort of change in fertility with age. There has been no thorough or careful investigation of this matter in the fowl, based on adequate statistical material.

The writer has lately studied[5] the change in fertility with age in poultry, on the basis of 1114 matings of Barred Plymouth Rock fowls, covering in point of time a period of nine years. For the purposes of this investigation, and generally, the writer has defined *fertility* as the total net reproductive capacity of pairs of organisms, male and female, as indicated by their ability to produce *viable* individual offspring. As a working measure of fertility may be taken a reproductive or fertility index which expresses the percentage which the number of viable offspring actually produced from a particular mating or pair of parents is of the maximum number which would be physiologically possible within the time limits during which the mating endures. This states, in most general terms, the form of index developed for the special case of poultry breeding in the present investigation. The same idea can be adapted to the measurement and biometrical study of fertility in other sorts of animals, and probably in plants as well.

Specifically, the reproductive, or fertility index used in the work for poultry has the following form:

$$RI = 100C/E_m$$

where RI denotes the index for any particular mating, C the number of chickens produced from that mating and alive at the end of the third week after hatching, and E_m the total number of days from the day when this mating began to the day when the last egg from this mating began its incubation.

The reasoning on which this index is based is as follows: Maximum reproductive capacity, as represented by 100%, would be attained if during the period of the mating the hen laid one egg every day (maximum fecundity), and if further every one of such eggs were fertile, and if each embryo hatched, and the hatched chick lived to be three weeks of age. There would then be one living chick three weeks of age for each day during which the mating existed. If the hen does *not* lay every day during the mating season this will cause some reduction in the reproductive performance as measured by the index. Similarly a reduction in any of the other factors involved, prenatal or postnatal mortality, will have the same sort of result. The final percentage value which one obtains by calculating the index will be a true measure of the reproductive capacity of that mating, including within its view all of the primary factors of reproduction in poultry.

Applying this index to the problem of changing fertility with advancing age we have the following results:

Weighted mean reproductive indices for males of specified ages mated with females of all ages

Ages	*Weighted mean RI*
Male = 1, mated with ♀ ♀ of all ages	12.868
Male = 2, mated with ♀ ♀ of all ages	10.214
Male = 3, mated with ♀ ♀ of all ages	9.625

Weighted mean reproductive indices for females of specified ages mated with males of all ages

Ages	*Weighted mean RI*
Female = 1, mated with ♂ ♂ of all ages	12.765
Female = 2, mated with ♂ ♂ of all ages	11.660
Female = 3, mated with ♂ ♂ of all ages	10.722

From these figures it appears that there is a decline in net reproductive ability or fertility, as measured by the reproductive index, with advancing age in both sexes. The rate of the decline is, however, more rapid in the male than in the female.

It is desirable also to look at the matter from the standpoint of the mating. This may be done by taking means (weighted in proportion to the frequencies involved) of the reproductive indices for the advancing combined ages of the two animals entering into each class of matings. If this is done we get the following results:

Weighted mean reproductive indices for matings of individuals of the specified combined ages

Combined ages of mated individuals when mated	*Cases*	*Weighted mean RI*
2 years	796	13.083
3 years	190	11.121
4 years	113	11.119
5 years	12	7.458

The cases are too few to give reliable results after a combined age of four years. Up to that point, however, what occurs is this: There is a significant drop in reproductive ability as we pass from a combined age of two years for the mated birds to three years. In passing from three years to four there is no significant change in reproductive ability. In passing from a combined age of four years to that of five years there is a large drop in the net reproductive ability of the mating.

All of these figures agree in indicating that in the strain of the domestic fowl with which this work was done there is nothing approaching that law of fertility which has been found to hold for mammals, as pointed out at the beginning. Instead we find a steady and progressive decline in fertility after the first breeding season.

[1] Marshall, F. N. A., *The Physiology of Reproduction*, London, 1910, xvii + 706 pp.
[2] Pearl, R., *Science, New York*, N. S., 37, 1913 (226–228).
[3] King, H. D., *Anat. Rec., Philadelphia*, 11, 1916 (269–289).
[4] Pearl, R., *J. Exp. Zool., Philadelphia*, 13, 1912 (155–268).
[5] A complete and detailed report of this work will appear presently in *Genetics*.

A KINETIC HYPOTHESIS TO EXPLAIN THE FUNCTION OF ELECTRONS IN THE CHEMICAL COMBINATION OF ATOMS

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Beginning with Davy[1] and Berzelius, during the first part of the nineteenth century chemists generally accepted the theory that chemical combination is due to electrical forces, but when Dumas discovered the chloroacetic acids in which chlorine atoms, supposedly negative, replace positive hydrogen atoms it was believed that the theory had been shown to be false and it was practically abandoned. Following this, for fifty years or more, a theory of valence which took no account of electrical forces was developed and while occasional reference was made to positive and negative atoms and groups, no definite meaning in an electrical sense was attached to these expressions. Helmholtz in his Faraday lecture in 1881[2] drew the attention of chemists once more to the very